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Insect pests of spice crops and their management

Spice crops in India, including black pepper, cardamom, ginger, and turmeric, are vulnerable to diverse insect pests that significantly impact productivity and quality. This paper reviews major insect pests of spice crops, their biology, damage symptoms, seasonal incidence, and integrated management strategies. Emphasis is given to eco-friendly approaches such as biological control, cultural practices, and use of botanicals alongside judicious chemical use to ensure residue-free produce.

INDIA ranks among the top producers, consumers, and exporters of spices globally. Spices contribute significantly to the country's agricultural exports and play an essential role in the economies of the states where they are cultivated. More than 50 plant species are grown for their spice value across diverse agro-ecological zones, covering approximately 4.7 million ha and yielding around 11.9 million tonnes annually (2024–25).

Among vegetatively propagated spices, black pepper (*Piper nigrum* L.), cardamom (*Elettaria cardamomum* Maton), ginger (*Zingiber officinale* Rosc.), and turmeric (*Curcuma longa* L.) contribute substantially to both domestic production and spice exports. Tree spices form another important category; although their cultivation area is relatively limited, they are often imported to meet domestic demand. Prominent tree spices such as cinnamon (*Cinnamomum verum* Bercht. et Presl.), clove (*Syzygium aromaticum* L.), and nutmeg (*Myristica fragrans* Houtt.) are primarily grown in the hill regions of Kerala, Tamil Nadu, and Karnataka.

Spice crops in India are affected by a diverse range of arthropod and vertebrate pests, many of which cause significant economic damage by reducing crop productivity. It is crucial to implement environmentally sustainable integrated pest management (IPM) strategies in spice cultivation. Overreliance on chemical pesticides can lead to pesticide residues in the harvested produce, harm to beneficial insects such as pollinators and natural enemies, resistance development in pests, and broader environmental contamination.

This chapter provides an overview of the pest species that affect key spice crops in India–namely black pepper, cardamom, ginger, turmeric, coriander, cumin, fennel, fenugreek, cinnamon, clove, and nutmeg–highlighting their damage potential, biology, ecology, and management practices.

Black pepper

Black pepper is one of the most economically important spice crops and is susceptible to infestation by over 50 insect species in India. These pests target different parts of the plant including the roots, shoots, leaves, spikes, and berries. Among them, a few are considered major pests due to their widespread occurrence and significant impact on crop productivity.

Pollu beetle (Lanka Ramakrishnai)

The pollu beetle is regarded as the most serious insect pest affecting black pepper in India. Infestation rates on berries range from 6% to as high as 40%. The pest is more prevalent in lowland regions–particularly in areas below 300 meters above mean sea level–while infestations are less severe at elevations above 900 meters. Damage tends to be greater in shaded areas of plantations.

Nature of damage: Adult beetles scrape the surface of young leaves, shoots, and spikes, resulting in black, sunken lesions. Feeding on leaves creates small, irregularly shaped circular holes. Severely infested plant parts often succumb to secondary infections, leading to rotting and premature dropping. Grubs bore into immature berries, consuming their internal tissues. Affected berries first turn yellow, then blacken and disintegrate under pressure. A single grub may damage 2–4 berries in a cluster. In some cases, the grub damages the main axis of the spike while tunneling between berries, causing the distal end of the spike to dry up entirely.

Biology: The pest completes multiple, overlapping generations each year. Mature grubs are approximately 5.5 mm long and creamy yellow in colour. The larval stage comprises three instars and can last up to 40 days. Adults are about 2.5 mm long, with a yellowish-brown head and thorax and black elytra. The hind femora are enlarged, allowing the beetle to jump quickly when disturbed. Females can be distinguished by a sclerotized spine located on the mid-ventral wall of the genital chamber.

Management: Effective management of pollu beetle involves an integrated approach combining cultural and chemical methods. Regular removal of weeds and destruction of infested berries help minimize pest incidence by reducing breeding sites. Cultivars such as *Kalluvally* and

Feeding damage on leaf

Infested spike

Grub inside a berry

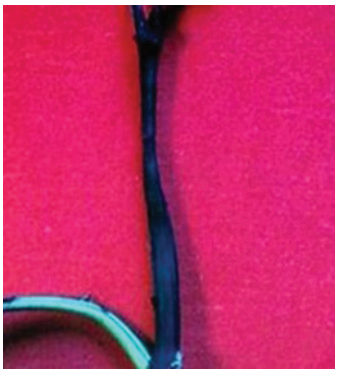
Karimunda have shown lower susceptibility and can be promoted in pest-prone areas. Shade regulation is also important, as excessive shading in plantations encourages pollu beetle population buildup; maintaining optimal light conditions can help suppress infestations. For chemical control, Chlorantraniliprole 18.5% SC (0.05%) can be applied during June–July and repeated in September–October. Alternatively, quinalphos (0.05%) may be applied in July, followed by neem-based insecticides (0.6%) during August, September, and October, which has also proven effective in managing the pest.

Top shoot borer (Cydia hemidoxa)

The top shoot borer is a significant pest of young black pepper vines, especially those between two and three years old, and is prevalent in both lowland and high-altitude plantations of Kerala. Infestation levels can be particularly severe in southern Kerala, where up to 48% incidence has been reported in one-year-old plantations. The pest is most active from July to October. Larvae bore into the tender terminal shoots and feed on internal tissues, causing the shoots to blacken, decay, and die–substantially stunting vine growth. A single larva typically completes its development within one internodal segment. When a terminal shoot is damaged, axillary shoots may emerge, but these too are vulnerable to further attack, resulting in repeated cycles of infestation. Continuous damage in the early stages of vine establishment can have serious consequences; studies have recorded up to 57% reduction in growth in vines subjected to three infestations within a year. Fully grown larvae are greyish-green and measure approximately 12–14 mm in length, with the larval period lasting up to 14 days. Although the pest can be found year-round, its population tends to peak during the monsoon period, particularly from August to December, when the presence of succulent new shoots facilitates active infestation.

Infested shoot with damaged tissues

Adult moth



Infested terminal shoot

Management: Management of the top shoot borer involves timely chemical and biological interventions. To protect the developing terminal shoots, application of quinalphos at a concentration of 0.05% is recommended twice a year, once in June and again in September. These treatments, which also target the pollu beetle, are generally effective in suppressing top shoot borer populations. In addition to chemical control, natural parasitism plays a role in regulating this pest. The parasitic nematode *Hexamermis* sp. and the parasitoid wasp *Apanteles cypris* have been observed attacking larvae, especially during August and September, contributing to natural suppression of the pest population.

***Leaf gall thrips* (Liothrips karnyi)**

Leaf gall thrips is a persistent and economically important pest of black pepper, particularly affecting young vines and nursery plants. Infestations are often more severe in high-altitude regions and in nurseries located in the plains. The thrips feed on tender leaves, leading to the curling of leaf margins inward and

downward, which results in the formation of distinct marginal galls. As the infestation progress, affected leaves become crinkled and deformed, significantly inhibiting the growth and development of young vines and cuttings. In cases of heavy infestation, the pest can substantially impact plant vigor and establishment. Adult thrips are black and measure approximately 2.5–3.0 mm in length, while the immature stages–larvae and pupae–are creamy white. Female thrips deposit clusters of creamy white eggs inside the galls, with hatching occurring in 6 to 8 days. The insect undergoes two larval instars followed by a pre-pupal stage and two pupal stages, with each developmental phase lasting approximately 4–7 days for the larvae, 2 days for the pre-pupa, and 2–3 days for each pupal stage. Infestations begin when the thrips colonize newly emerged tender leaves, where they remain until the leaves partially mature. Thrips populations typically increase during the monsoon season across several black pepper-growing regions.

Adult thrips on leaf

Marginal gall and eggs inside

Management: Natural enemies such as *Montandoniola moraguesi* and *Andothrips flavipes* are important regulators of this pest. Predators like *Geogarypus* sp., *Lestodiplosis* sp., and *Rhodesiella* sp. target the juvenile stages of the pest. For chemical control, foliar application of any systemic insecticide during the emergence of new leaf flushes, typically in June or July, has proven effective in reducing pest incidence and preventing the formation of galls.

Scale insects

Scale insect infestations in black pepper is a major problem in black pepper with infestation levels ranging from 20% to 47.5%. The mussel scale (*Lepidosaphes piperis*) is a major pest, affecting the main stems, lateral branches of younger vines, mature leaves, and even berries. Heavy sap extraction by this insect leads to the development of chlorotic spots on the leaves, which may eventually dry and fall. Young vines, especially those in their first or second year, are particularly vulnerable if the main stem is infested, while in older plants, the lateral branches may wilt and die under severe attack. In addition to field-grown vines, nursery plants in the plains are also susceptible to infestation. Another species, the coconut scale (*Aspidiotus destructor*), a highly polyphagous insect known to feed on more than 20 host plants in India, also affects black pepper by colonizing the leaves and occasionally the lateral branches and berries. Its feeding activity causes yellow spots or blotches to appear on the foliage. Adult females of *L. piperis* are elongate, dark brown, and measure 3–4 mm in length, while *A. destructor* females are smaller (1.5–2.0 mm), circular, and light yellow. Both species reproduce via parthenogenesis, allowing rapid population expansion when conditions are favorable.

Infested berries

Mussel scale

Coconut scale

Management: Managing scale insects requires both cultural and chemical strategies. Severely infested plant parts should be pruned and destroyed to prevent further spread of the pest. Chemical control involves the application of systemic insecticide, sprayed twice at 30-day intervals during January and February following the harvest. In nursery settings, neem oil at 0.3% or fish oil

rosin soap at 3% has shown good efficacy in controlling infestations. In addition to these measures, several natural enemies–such as *Aphytis* sp., *Pseudoscymnus* sp., and *Chilocorus circumdatus*–play a crucial role in suppressing scale insect populations in natural environment.

Mealybugs

Among the different mealybug species affecting black pepper, *Planococcus* spp. and *Ferrisia virgata* are the most important pests. These sap-sucking insects live in groups and are typically covered in a white, waxy secretion. Adult females are soft-bodied, oval in shape, and coated with waxy filaments. They are often associated with ants, which protect them in exchange for honeydew secretions. Mealybugs complete their life cycle in approximately 25 days. Root-infesting mealybugs are especially problematic when their presence coincides with *Phytophthora* infections or plant-parasitic nematodes, as this combination significantly accelerates vine decline. In addition to causing direct damage through sap feeding, *F. virgata* also acts as a vector for Piper yellow mottle virus (PYMoV), a major viral disease in black pepper. Although infestations may occur throughout the year, they tend to intensify during the post-monsoon season, starting in October.

Management: Effective management of mealybugs relies on early detection and integrated strategies, particularly in nurseries and plantations. Because the waxy covering of the adults reduces the efficacy of insecticides, targeting the crawler stage is critical. These insects often hide in crevices and leaf axils, making thorough spraying or drenching of the entire plant essential. Summer weed removal helps suppress root mealybug populations by eliminating potential alternate hosts. In the case of shoot and spike infestations, applying systemic insectide during the early stages or at 15-day intervals has been found effective. For root mealybug infestations, drenching with insecticides provides good control.

Small cardamom

Small cardamom is susceptible to infestation by numerous insect pests that adversely impact crop productivity at various stages of growth. Nearly 60 insect species have been recorded on small cardamom, but only a few are considered economically significant. One of the most destructive among them is the cardamom thrips.

Cardamom thrips **(Sciothrips cardamomi)**

The cardamom thrips (*Sciothrips cardamomi*) is regarded as the most serious pest affecting small cardamom plantations across Kerala, Karnataka, and Tamil Nadu. Both adult thrips and their nymphs feed on tender plant tissues, causing substantial damage. Infestation levels can affect 30% to 90% of the capsules, and crop losses may reach up to 48% in major production areas. These pests feed by lacerating the surface tissues of young leaves, shoots, panicles, flowers, and developing capsules to extract sap. Feeding on young capsules results in corky, scab-like patches, which cause the capsules to become deformed and shriveled, significantly lowering their market value and leading to major economic losses. Adult thrips are slender, greyish-brown insects, measuring about 1.5 to 1.75 mm in length, and possess fringed wings. Under favorable environmental conditions, they complete their life cycle in 16 to 22 days. Thrips populations tend to be higher in heavily shaded areas and increase rapidly in warm weather. Their abundance shows a positive correlation with maximum temperatures and sunshine hours, typically peaking during the post-monsoon period and decreasing with rainfall.

Management: Effective management of cardamom thrips begins with regulating shade in plantations by pruning branches of shade trees, which helps lower humidity and creates less favorable conditions for thrips proliferation. Trashing operations should be carried out three times a year, during early, mid, and late monsoon periods, prior to insecticide application to ensure better spray penetration and increase the effectiveness of thrips control. To minimize harm to pollinators, insecticide applications should be avoided during peak honey bee activity. Under field conditions in Karnataka, insecticidal sprays using fipronil (0.005%) or spinosad (0.0135%) have been found effective when applied during February–March, March–April, April–May, and again in September and October. Additionally, integrated pest management strategies incorporating the use of the entomopathogenic fungus *Lecanicillium psalliotae* along with spinosad offer a promising eco-friendly approach for managing this pest.

Adult thrips

Thrips infested cardamom capsules

Cardamom shoot and capsule borer **(Conogethes sahyadriensis)**

The cardamom shoot and capsule borer is one of the most destructive pests affecting cardamom cultivation, inflicting significant damage to both vegetative and reproductive plant parts. It infests plants in both nursery and field conditions, boring into shoots, panicles, and developing capsules. In cases of severe infestation, yield losses as high as 70–80% have been reported. The pest typically begins its attack at the early larval stage by boring into unopened leaf sheaths, immature panicles, and tender capsules. As the larvae mature, they penetrate deeper into the pseudostem and feed on internal tissues, leading to the characteristic "dead heart" symptom, where the central shoot dries up. Infested panicles may dry from the entry point of the larva, while the capsules become hollow due to seed destruction. A clear indication of infestation is the presence of frass (insect excreta) being pushed out from boreholes on the pseudostem, capsules, and other plant parts. Drying shoots, boreholes, and frass extrusion serve as visible signs of damage. Adult moths are moderate in size, measuring between 24 and 29 mm in wingspan, with pale straw-yellow to orange-yellow

wings marked with small black dots. The larval stage, which causes the most damage, includes five instars and lasts anywhere between 10 and 62 days. Full-grown larvae are light brown or pale pink, sparsely hairy, and measure approximately 30–35 mm in length.

Management: Effective management involves early detection and destruction of infested tillers, especially during the low-infestation period from September to October, when visible frass extrusion is observed. Timely application of insecticides is critical and should be aimed at the early larval stages before they bore deeper into plant tissues, where chemical control becomes less effective. To minimize the impact on pollinators such as honey bees, insecticide applications should be scheduled outside their peak foraging hours. Natural biological control agents, including parasitoids like *Agrypon* sp., *Friona* sp., *Apanteles taragamae*, *Xanthopimpla australis*, and *Temelucha* sp., contribute significantly to suppressing the pest population. For chemical management, spraying approved insecticides in February–March and again in September–October, aligned with the emergence of new shoots and panicles has proven effective in managing this pest.

Infested shoot with frass out of borer hole

Shoot borer adult

Shoot borer larva

***Cardamom root grub* (Basilepta fulvicorne)**

Root grubs are a significant subterranean pest in cardamom plantations, known for their destructive feeding on the roots and rhizomes of the plant. Their feeding activity severely compromises root integrity, often leading to yellowing, stunted growth, and ultimately plant death. Damage is most pronounced during two active periods: April to July and again from September to January. Adult beetles typically emerge during April and September. The grubs feed on the growing tips of roots, creating irregular gouges that affect tiller formation, delay panicle initiation, and overall reduce plant vigor, with recorded yield losses ranging from 29% to 66%. Eggs are deposited on decomposing cardamom leaves or mulch at the base of the plants. The larvae are short, thick, and C-shaped, with a developmental duration ranging between 45 and 60 days. Adults measure around 4–6 mm, are metallic blue or green in color, and can be seen feeding on cardamom foliage, although they may also be found on alternative hosts like jackfruit. The species completes two generations per year, the first being from March to August and the second from September to February.

Management: Control measures should include the manual collection and destruction of adult beetles during their mass emergence in April–May and September–October. For chemical control, application of chlorpyriphos at 0.075% twice annually during May–June and again in August–September to coincide with periods of beetle activity and egg laying. Enhancing the efficacy of insecticidal treatments can be achieved by lightly raking the soil surface before application, ensuring better penetration and contact with the grubs residing in the root zone.

Root grubs

Infested plant

Adult beetle

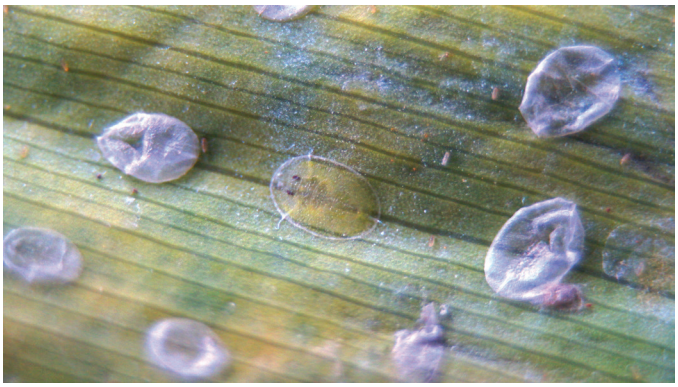
***Cardamom shoot fly* (Formosina flavipes)**

The cardamom shoot fly is a significant pest that primarily targets seedlings and young tillers, especially during the warm summer months. Infestation tends to be more severe in plantations with sparse shade and high humidity, which support the survival of eggs and pupae. The pest remains most active under moderate temperature conditions. One of the most identifiable symptoms of shoot fly damage is the "dead heart" formation, where the infested tiller dries, wilts, and shows stunted growth. Splitting open the affected shoots typically reveals the presence of yellowish-white maggots actively feeding within the core tissues. Adult flies lay distinctive cigar-shaped eggs on the plant, and upon hatching, the maggots bore into the central growing shoot, damaging vital tissues and ultimately killing the terminal shoot. Pupation occurs inside the pseudostem.

Management: It is essential to remove and destroy infested shoots by cutting them at the base to halt further spread of shoot fly infestation. The use of fish meal traps

Shoot fly maggot

Shoot fly Pupa



Whitefly nymphs

Dead shoot

infested shoot with maggots

Matured nymph

Adult whitefly

can effectively attract and capture adult flies, thereby minimizing their reproductive potential. Ensuring adequate shade in plantations creates a less favorable microclimate for the pest, helping to suppress its population. Promoting good plant health through proper spacing, optimal nutrition, and sanitation also helps reduce susceptibility. Regular monitoring allows for early detection and timely intervention. For chemical management, spraying systemic insecticide is recommended, while neem seed kernel extract at 5% concentration offers a safer, natural alternative for pest suppression.

Whiteflies

Among the five species of whiteflies reported on small cardamom, *Kanakarajiella cardamomi* is considered the most destructive. Adult whiteflies are small, soft-bodied insects, approximately 2 mm in length, with two pairs of white wings. Though weak fliers, they can move between plants and have a lifespan of up to eight days. Both adults and nymphs pierce plant tissues and suck sap in large numbers, leading to yellowing of leaves, reduced plant vigour, and, in severe cases, plant death. Nymphs secrete honeydew, a sticky substance that fosters the development of sooty mould, which further interferes with photosynthesis by covering leaf surfaces. The life cycle is completed in 40–60 days, beginning with egg-laying on the undersides of leaves. The mobile crawler stage searches for a feeding site, after which the insect remains sedentary through the rest of its nymphal stages, culminating in a puparium from which the adult emerges, leaving behind a white, scaly residue.

Management: Effective control of whiteflies involves a combination of physical, biological, and chemical strategies. Yellow sticky traps made from tin or plastic sheets painted with highway yellow and coated with castor oil, grease, or gum can effectively trap and kill adult whiteflies. Natural enemies such as predators (including *Mallada boninensis*, ladybird beetles, dragonflies, spiders, and predatory mites) and parasitoids like *Encarsia* spp., *Eretmocerus* spp., and *Chrysocharis* spp. play a significant role in naturally regulating whitefly populations. The entomopathogenic fungus *Aschersonia placenta* has also been reported to suppress infestations effectively. For chemical control, the application of Fish Oil Rosin Soap or insecticidal soap has proven successful in reducing pest numbers. During early infestation, spraying diafenthiuron 50 WP at 800 g per 1,000 L of water provides effective management. Additionally, neem-based formulations containing azadirachtin may be used as a safer, plant-based alternative.

Ginger and turmeric

Ginger and turmeric are perennial herbaceous crops cultivated primarily for their rhizomes, which are widely used as spices. Several insect pests affect these crops, and some of the major pests along with their management strategies are outlined below.

Shoot borer **(Conogethes punctiferalis)**

The shoot borer is a major insect pest affecting both ginger and turmeric, causing considerable economic loss. In turmeric, infestations can result in up to 75% shoot damage and yield losses of approximately 26%. The larvae bore into pseudostems and feed on internal tissues, leading to yellowing, wilting, and drying of shoots. Typical signs of infestation include a visible bore-hole on the pseudostem through which frass (insect excreta) is ejected, and a central shoot that turns yellow and collapses. Infestation levels peak during September and October. The pest is highly polyphagous, known to attack more than 120 plant species. Adult moths lay eggs on tender leaves, and upon hatching, the larvae initially feed on chlorophyll before boring into the stems. Fresh infestations are characterized by frass deposits and chewed plant tissue near the bore holes. With severe damage, the central shoot may die, and yield losses can reach up to 38 grams per clump when half of the shoots are affected. Adult moths are medium-sized, with straw-yellow to pale orange wings marked by small black spots.


Infested ginger shoot


Dried shoot ginger


Infested turmeric shoot

Management: Effective management of shoot borer includes cultural, chemical, and integrated strategies. Pruning and destroying freshly infested shoots at fortnightly intervals from July to August in ginger helps reduce larval populations early in the season. For chemical control, spraying chlorantraniliprole 18.5% SC 0.01% or spinosad 45% SC 0.0225% or lambda cyhalothrin 5% EC 0.01% at 15-21 days intervals starting 45 days after planting has been found to be effective. Additionally, an entomopathogenic fungus, *Metarhizium pingshaense* has been found to very effective for biological control of this insect pest.

Rhizome scale **(Aspidiella hartii)**

Rhizome scale is a significant pest of ginger and turmeric, especially during storage, and is widely prevalent across all major cultivation regions. The pest also affects other tuber crops, including elephant foot yam (*Amorphophallus paeoniifolius*), yams (*Dioscorea* spp.), taro (*Colocasia esculenta*), and tannia (*Xanthosoma sagittifolium*). Adult female scales are circular, light brown to grey, and about 1.5 mm in diameter. Infestation typically begins during the late growth stages in the field, but the problem escalates post-harvest when infected rhizomes are stored. During storage, the scale insects proliferate rapidly, feeding on the rhizomes and causing shriveling of buds, rendering them unsuitable for planting and reducing their market value.

Management: To manage rhizome scale effectively, timely harvesting of the crop is critical, along with the removal and destruction of heavily infested rhizomes during storage. An integrated strategy includes dipping seed rhizomes in systemic insecticide before storage to eliminate active infestations. After treatment, the rhizomes should be stored in a 1:1 mixture of dried *Strychnos nux-vomica* leaves and sawdust, which has been shown to significantly reduce scale build-up. This comprehensive approach minimizes infestation during storage and preserves the quality and viability of seed rhizomes.

Leaf Roller **(Udaspes folus)**

The leaf roller is widely distributed in major ginger and turmeric growing regions and also reported across several Southeast Asian countries. It predominantly feeds on plants in the Zingiberaceae family. The larvae cut and roll the margins of leaves, creating protective shelters in which they feed. Adult butterflies are medium-sized, with a wingspan of 20 × 45 mm, and are characterized by brownish-black wings with prominent white spots. The insect's life cycle includes an egg stage lasting 4–5 days, a larval stage of 13–25 days (comprising five instars), and a pupal stage of 6–7 days. Fully grown larvae are olive green, while pupae are light green with a beak-like anterior and tapering posterior. Management practices recommended for shoot borer have been effective against leaf roller infestations.

Root Grubs **(Holotrichia *spp.*)**

White grubs are serious underground pests of ginger, feeding on roots and newly developing rhizomes. Their feeding leads to yellowing of leaves, wilting, shoot death, and, in severe cases, complete crop loss. Adult beetles also cause defoliation in *Ficus* species. Management includes the mechanical collection and destruction of adult beetles during their peak emergence, especially during the early monsoon season. Biological control using the entomopathogenic fungus *Metarhizium anisopliae*, when applied along with fine cow dung to the soil, has shown effectiveness in suppressing grub populations. In areas experiencing severe infestation, drenching the soil with chlorpyriphos (0.075%) combined with manual beetle removal offers an integrated and reliable control strategy.

Leaf Beetle **(Lema *spp.*)**

Leaf beetles, particularly *Lema* species, are notable foliar pests of turmeric, especially prevalent during the monsoon season. Both adult beetles and their grubs scrape chlorophyll from the leaves, resulting in long, parallel, white streaks that diminish photosynthetic efficiency and plant vigor. Effective control of leaf beetles can be achieved using the same chemical treatments used against shoot borers.

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Integrated pest and disease management in cumin

An integrated management schedule for blight and aphids in cumin was standardized. Three foliar sprays of kresoxym methyl 44.3 SC was developed @ 0.044% (First with initiation of disease and subsequently at 15 days interval) and two foliar sprays of thiamethoxam 25WG @ 0.0084% (First with the initiation of aphid infestation and the second after 10 days) were found effective for obtaining a higher yield (677 kg/ha) and incremental benefit-cost ratio (1.98) with less blight (PDI=16.06%) and aphid incidence (Aphid Index=0.96) under Jagudan (Gujarat) conditions.

Source: ICAR Annual Report 2023-24, p.86